ACHIEVING TARGET 8 OF THE GLOBAL STRATEGY FOR PLANT CONSERVATION: LESSONS LEARNED FROM THE NORTH AMERICAN COLLECTIONS ASSESSMENT[1]

Abby Hird[2] *and Andrea T. Kramer*[3]

ABSTRACT

How much progress has North America made toward the Global Strategy for Plant Conservation (GSPC) Target 8 of at least 75% of threatened plant species in accessible ex situ collections by 2020? To answer this, the North American Collections Assessment was carried out in 2010. More than 200 botanical and conservation institutions in the United States, Canada, and Mexico contributed taxa lists to the Botanic Gardens Conservation International's (BGCI) online PlantSearch database for this assessment. By cross-referencing collection information with globally threatened species lists from the International Union for Conservation of Nature and Natural Resources (IUCN), NatureServe, and Mexico's Red List, we found that approximately 35% of North America's nearly 5000 most threatened taxa are currently in ex situ collections. This marks considerable progress toward the GSPC Target 8, but there is clearly much more to do. Future priorities include collaboratively and strategically increasing threatened species representation in collections and assessing genetic diversity among collections by comparing accession-level data.

Key words: Botanic garden, ex situ plant conservation, Global Strategy for Plant Conservation (GSPC), living plant collection, seed bank.

Well-documented, genetically diverse living plant and seed bank collections at botanic gardens and similar institutions support integrated plant conservation (Fig. 1) and provide critical insurance for many of the plant species now threatened with extinction, recently estimated at 100,000 total worldwide (Pitman & Jorgensen, 2002; Guerrant et al., 2004). But how many threatened species are safeguarded in collections, and which are not? While the botanical community as a whole does not know the actual representation in collections of threatened species, the Botanic Gardens Conservation International (BGCI) has a growing number of tools in place to help botanic gardens leverage their collective resources to address this and other challenges ahead.

OUR CONTRIBUTIONS TO THE GLOBAL STRATEGY FOR PLANT CONSERVATION

Botanic gardens have a global mandate to provide a safety net against extinction for threatened plants. The Global Strategy for Plant Conservation (GSPC), ratified by nearly every country in the world, was adopted by the Parties to the Convention on Biological Diversity in 2002 (CBD, 2002). The development and adoption of the GSPC were largely due to the efforts of the global botanic garden community, and we now play a key role in achieving its 16 outcome-oriented targets to halt the loss of plant diversity worldwide. Directly relevant to botanic gardens and their collections, GSPC Target 8 sets a goal to have at least 75% of threatened plants in accessible ex situ collections by 2020. While resources to meet this important target might be limited, the individual and collaborative work of botanic gardens and conservation organizations has made great progress in building ex situ conservation collections as a global safety net for threatened species. As the 2020 deadline approaches, it is critical that we know where we stand relative to this

[1] The North American Collections Assessment was carried out by the Botanic Gardens Conservation International (BGCI) U.S. in partnership with the United States Botanic Garden and the Arnold Arboretum of Harvard University, with additional funding from the Wallace Genetic Foundation. Collaboration with many organizations and botanic gardens throughout North America made this project possible, including the American Public Gardens Association, Center for Plant Conservation (CPC), Canadian Botanical Conservation Network, and Mexican Association of Botanical Gardens. Thanks are extended to all contributors for their support and participation, Suzanne Sharrock and Meirion Jones at BGCI, and special thanks to assessment co-authors Ray Mims, Michael Dosmann, and Kirsty Shaw.

[2] Botanic Gardens Conservation International U.S. at the Rancho Santa Ana Botanic Garden, 1500 N. College Avenue, Claremont, California 91711, U.S.A. abby.hird@bgci.org.

[3] Botanic Gardens Conservation International U.S. at Chicago Botanic Garden, 1000 Lake Cook Road, Glencoe, Illinois 60022, U.S.A. andrea.kramer@bgci.org.

doi: 10.3417/2011114

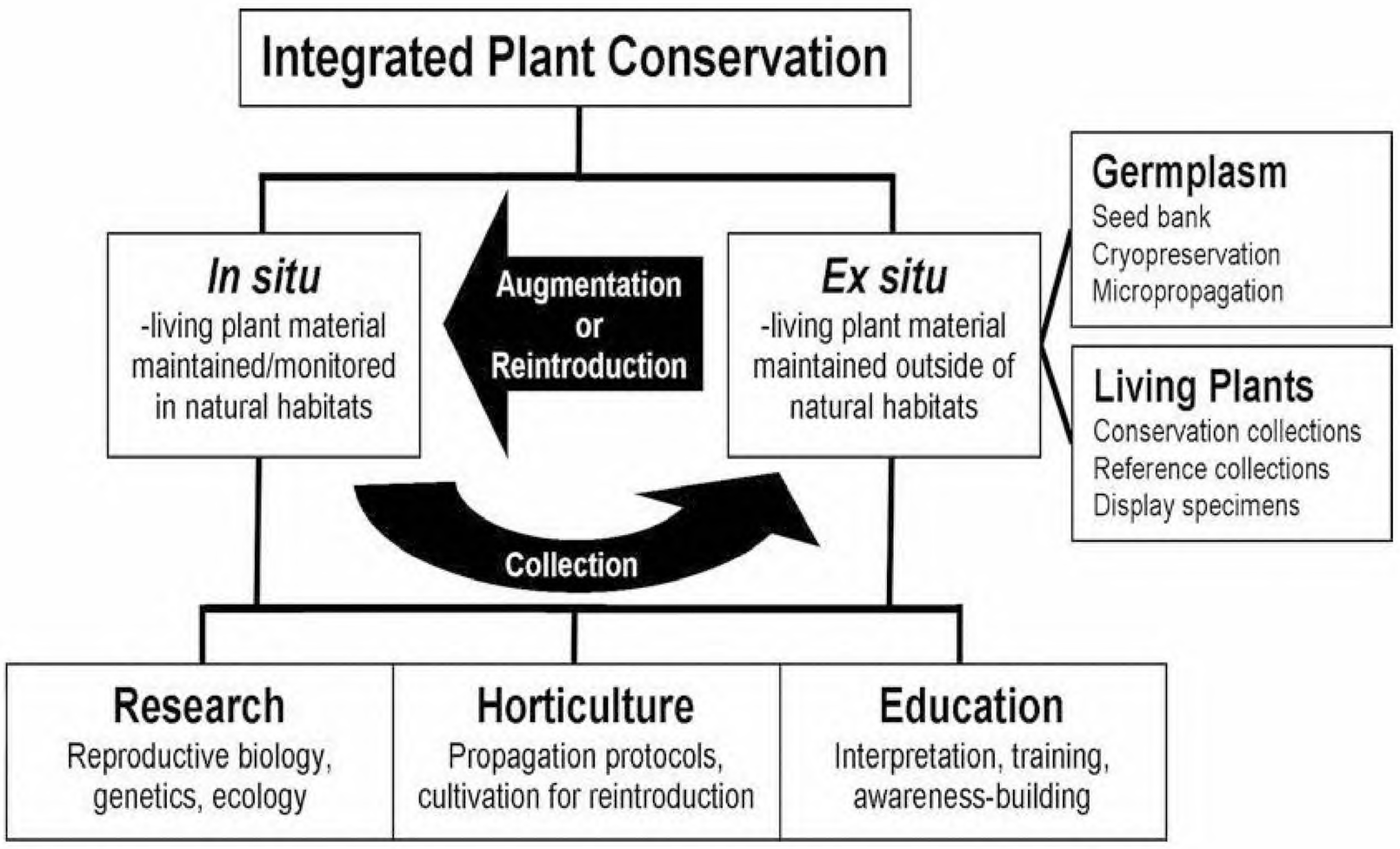


Figure 1. Integrated plant conservation combines in situ (on-site) and ex situ (off-site) conservation action to support species survival. In situ conservation protects species in their native habitat, while ex situ conservation ensures plant material is available for research, horticulture, and education activities that ultimately support reintroduction efforts, ensuring that ideally no species goes extinct.

ambitious target in order to inform future strategic and collaborative conservation efforts.

Measuring Global Progress

When the GSPC was adopted in 2002, the BGCI launched PlantSearch, an online database of botanic garden collections, as a means to measure basic, taxon-level progress toward the GSPC Target 8 (BGCI, 2012b). The PlantSearch database remains the only resource available to measure global progress toward the GSPC Target 8 and represents the only global database of plants in cultivation. All institutions that curate collections of living plants, banked seeds, or other plant germplasm are encouraged to upload a list of taxa in their collections to PlantSearch on an annual basis. This free database not only facilitates estimates of national and global progress toward Target 8, but also provides invaluable data for institutions to prioritize their collection efforts and to connect their collections to other collection holders and researchers nationally and worldwide. This connectivity makes such institutional collaboration and biological research on the conservation of threatened plant species more efficient and effective.

In 2010, the BGCI analyzed the data in PlantSearch and found that only 23% of all threatened plants, i.e., as included on the International Union for Conservation of Nature and Natural Resources (IUCN) Red List (IUCN, 2010), are known to be maintained in ex situ collections worldwide. These results are presented in a recent report on botanic gardens and the implementation of GSPC Target 8 (Sharrock et al., 2010). A similar report focused on threatened European plants found that 44% were held in ex situ collections (Sharrock & Jones, 2011). While this indicates positive progress, these results are also a call to action as they fall well short of the 2020 GSPC target of 75%. Highlighted below, the assessment of threatened North American plant species in collections (Kramer et al., 2011) exemplifies both the achievements made and limitations faced in North America as we work to conserve plant species and achieve the GSPC Target 8 by 2020.

Measuring North American Progress

In 2010, the BGCI U.S. partnered with the United States Botanic Garden and the Arnold Arboretum of Harvard University to conduct a North American Collections Assessment, the results of which were recently published and distributed as a report, available online and in print (Kramer et al., 2011). This assessment measured progress toward the GSPC Target 8, specifically within the North American botanical and conservation communities. This project resulted in the first compilation of North American threatened species lists from the varying systems used in the United States, Canada, and Mexico, i.e., NatureServe global threat ranks (NatureServe, 2012), IUCN Red List ranks (IUCN, 2010), and Mexico's NOM Red List (NORMA, 2001; Fig. 2). Taxonomic lists were utilized from over 200 institutions via the PlantSearch database to identify the number of

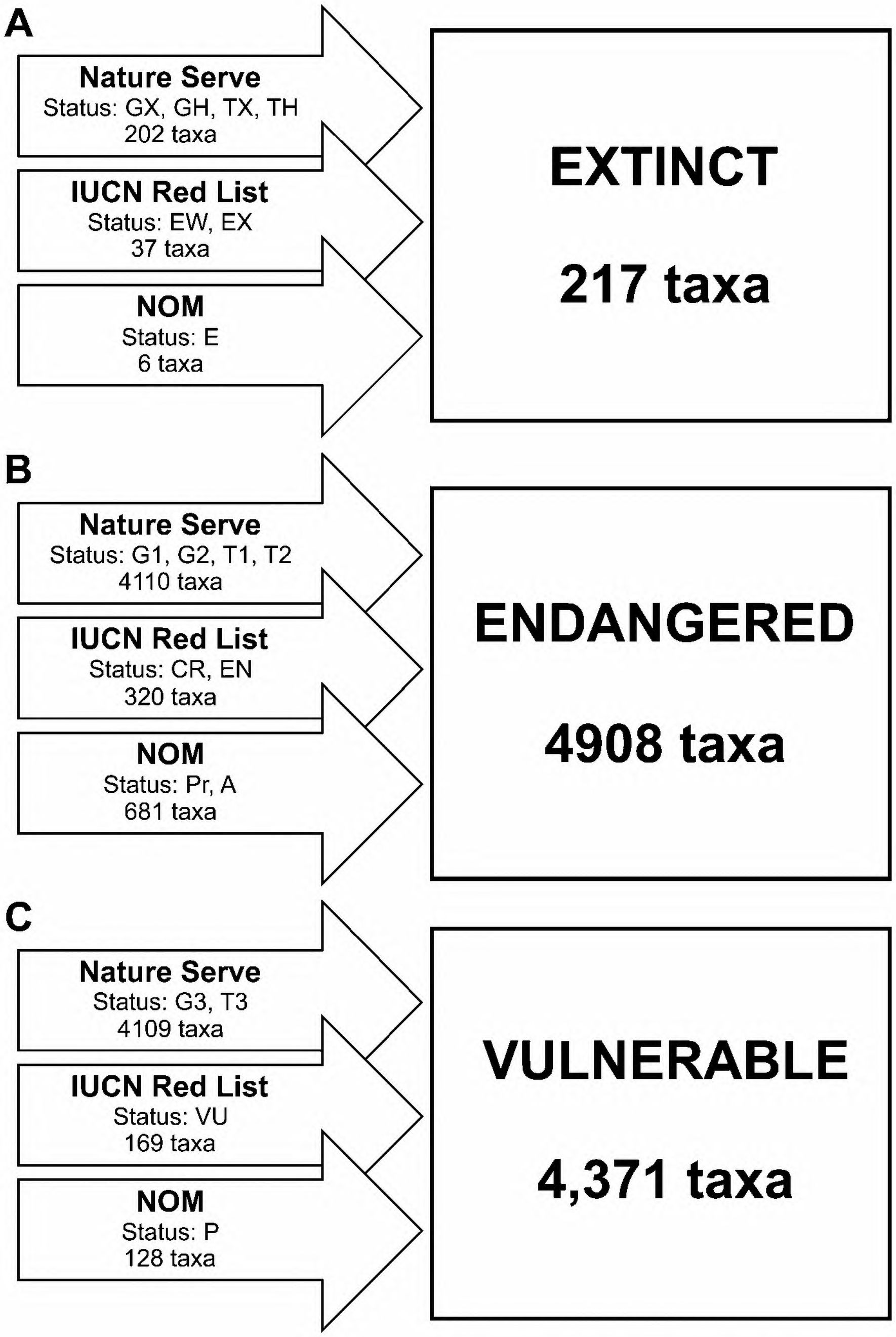


Figure 2. Three threatened species lists (NatureServe for Canada and the United States, NatureServe, 2012; IUCN Red List for plant taxa globally, IUCN, 2010; and the NOM Red List for Mexico, NORMA, 2001) were compiled into three categories (Kramer et al., 2011). —A. Extinct species are represented by NatureServe's assessments of GX or GH (presumed extinct or eliminated or possibly extinct or eliminated) and TX or TH (equivalent to GX or GH, but for a subspecies or variety); by IUCN's EX or EW (extinct or extinct in the wild); and by NOM's E (Probablemente extinta en el medio Silvestre, Probably extinct in the wild). —B. Endangered plant taxa are assessed by NatureServe as G1 or G2 (globally critically imperiled or imperiled) and T1 or T2 (equivalent to G1 or G2, but for a subspecies or variety); by IUCN as CR or EN (Critically Endangered or Endangered); and by NOM as Pr (Sujetas a protección especial, Subject to special protection). —C. Vulnerable taxa are categorized by NatureServe as G3 (globally vulnerable) and T3 (equivalent to G3, but for a subspecies or variety); by IUCN as VU (Vulnerable); and by NOM as P (En peligro de extinción, At risk of extinction). NatureServe rankings may be found at <http://www.natureserve.org/explorer/ranking.htm>; IUCN categories and criteria at <http://www.iucnredlist.org/documents/redlist_cats_crit_en.pdf>; and NOM criteria at <http://www.biodiversidad.gob.mx/pdf/NOM-059-ECOL-2001.pdf>.

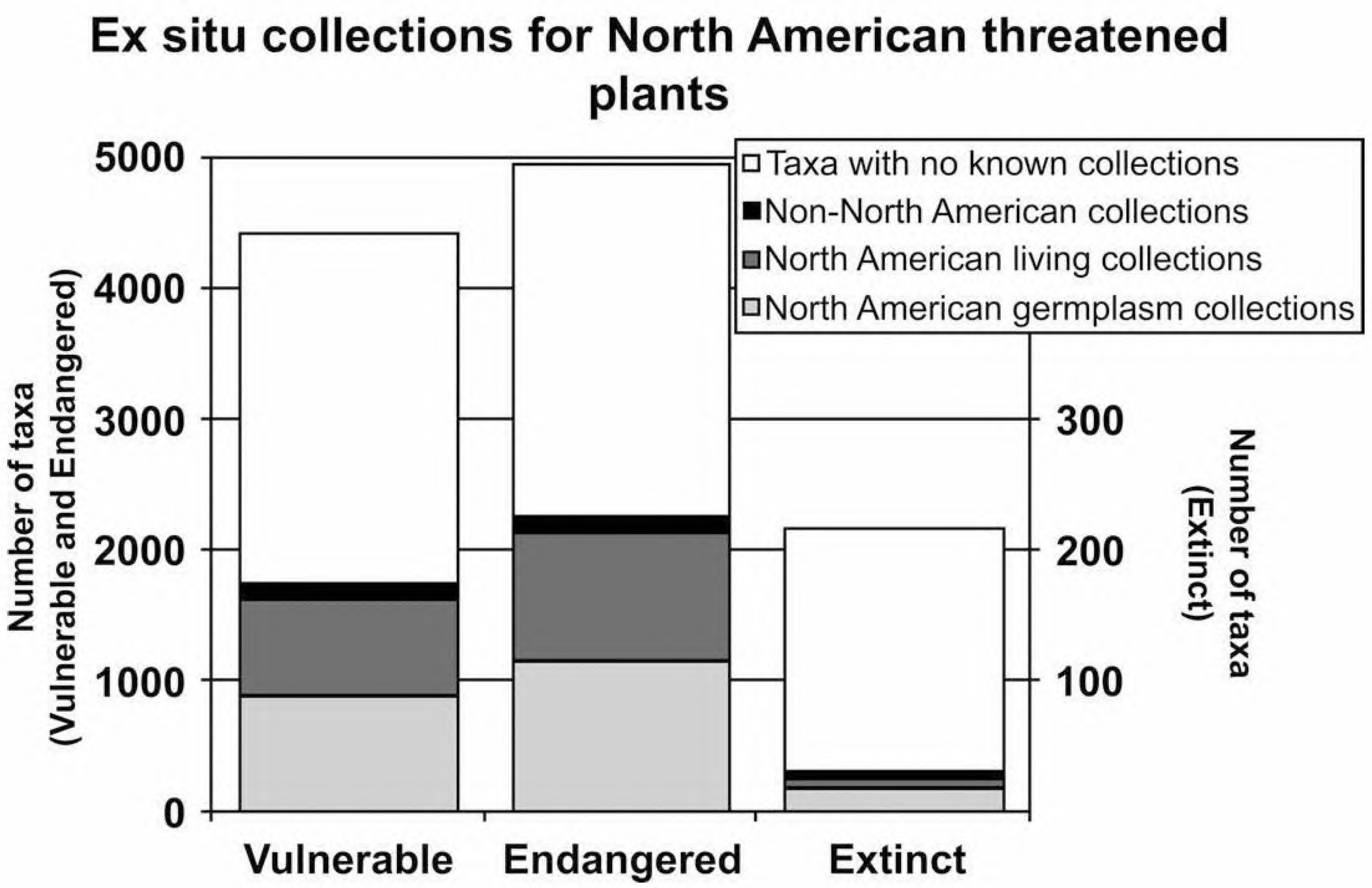


Figure 3. North American threatened taxa in ex situ collections. Threat category corresponds to the summed assessments seen in Figure 2 (endangered, vulnerable, and extinct). Light gray shading refers to germplasm (as seed banked, cryopreserved, or micropropagated material) and dark gray shading refers to living collections (plants). Note the 10-fold difference in y-axes for endangered and vulnerable plant taxa (at left) as compared to the known extinctions (at right).

threatened species maintained ex situ in North America.

Overall, data analyses revealed that 35% of the nearly 5000 most threatened North American species are maintained ex situ either as living plants or germplasm maintained in seed banks or as cryopreserved or micropropagated material (Fig. 3). Of particular concern, we found that nearly half of all endangered plant taxa identified in collections are maintained at only one institution (Fig. 4), which could lead to an ex situ bottleneck and reduction in genetic diversity. Taxa found in only one living plant collection likely exist as one or few specimens potentially of unknown or cultivated origins, which would capture little genetic diversity. This paucity in taxonomically representative specimens might rarely, if ever, be able to support successful reintroductions of extirpated populations.

Conversely, our assessment results are probably a slight underestimate of the number of threatened species in ex situ collections, as only 30% (230) of the known public gardens and similar institutions with living plant and germplasm collections in North America participated in the assessment (http://www.bgci.org/files/UnitedStates/NACA/naca_appendix_1.pdf; Kramer et al., 2011). Efforts were made, however, to ensure that institutions that support conservation of threatened species were able to upload a taxa list to PlantSearch. A large majority of gardens active in the Center for Plant Conservation (CPC) network (90.6%; CPC, 2012) and members of BGCI (85.6%) contributed taxa lists. Further, all but one (54) U.S. gardens reporting an ex situ conservation program in the GardenSearch database were able to contribute to the assessment (BGCI, 2012a). Many of the institutions unable to participate reported insufficient staff or technological resources to provide an electronic list of taxa in their collections. Regardless, these results indicate that we have much work ahead to ensure 75% of North America's threatened species are in accessible ex situ collections by 2020.

Summary and Future Work

It is clear that in order to achieve the GSPC Target 8 by 2020, North American botanical and conservation organizations must increase the number of species held in ex situ collections designed for conservation. Use of information compiled through this and similar assessments can facilitate the prioritization of species acquisitions at individual gardens and aid the broader botanical and conserva-

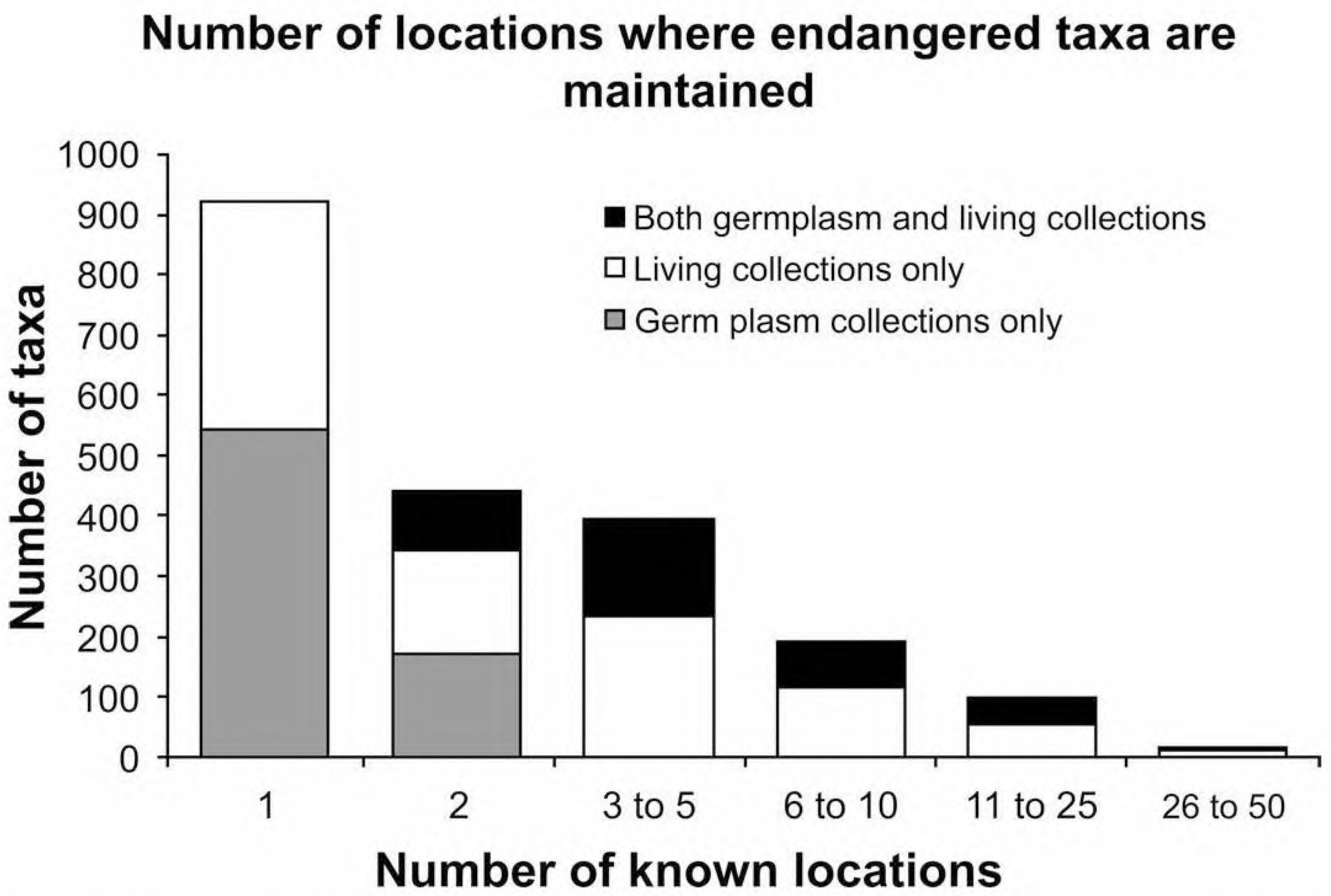


Figure 4. Representation of 2208 North American endangered taxa held in 230 ex situ collections (see Fig. 2 for details). Institutional locations are partitioned by collection type as germplasm (seed banked, cryopreserved, or micropropagated), living plants, or both. Note that many endangered taxa are held at only a single institution.

tion communities to work more effectively toward the successful achievement of Target 8. Additionally, assessments such as this allow progress over time to be documented and monitored, while providing quantitative data that demonstrate the collective impact and value of collections work.

Most institutions with ex situ collections of threatened plants can utilize the integrated plant conservation model to support important conservation, education, and research applications for those species (Fig. 1). Living plant collections in particular can promote threatened species conservation even if they were not designed to have direct, in situ conservation applications. Botanic gardens of every size and scope are uniquely positioned to wield their ex situ collections as tools to educate the public about conservation issues and the importance of plant diversity.

Living plant collection can also be used for research of understudied species (e.g., life history, ecology, propagation, pests/pathogens, or potential invasiveness) to improve conservation methods. Not all collections provide equal conservation value, however. While most collections of threatened plants can make important contributions to broader plant conservation initiatives through conservation-focused interpretation and education, not all collections provide direct conservation value at the research or reintroduction levels. Well-curated collections (living plant or germplasm) created from wild-collected, source-identified plant material can best support research and reintroduction applications for conservation.

Unfortunately, we do not currently understand the true conservation value of many of the collections included in this assessment. This must be resolved in the future by compiling and comparing accession-level data across living plant and germplasm collections to assess representation of natural populations in ex situ collections. We do know, however, that seed banks generally provide the highest conservation value in the most efficient manner, as they typically capture broad genetic diversity at relatively low costs over a long period of time. Seed banks can also provide plant material that is accessible and has direct, in situ conservation applications, to augment declining populations or reintroduce extirpated populations as needs arise. Therefore, there is an imperative to focus ex situ conservation efforts on building and strengthening seed bank collections for threatened species that produce orthodox seeds (able to be dried and stored). Currently in the United States, the collaborative network of the CPC is building secure, genetically

diverse seed bank collections for hundreds of the nation's most imperiled flora (CPC, 2012), and work like this is growing around the world.

For species with recalcitrant seeds or species that are no longer able to produce seeds at all, other types of collections can be well suited to provide adequate conservation value. This includes micropropagated and cryopreserved collections of plant tissue, which can efficiently capture relatively high genetic diversity and provide direct conservation applications. However, cryopreserved collections are more expensive than seed banks to maintain long term, and protocols for long-term cryopreservation have not yet been perfected for many threatened species (e.g., threatened oak species in the United States; Kramer & Pence, 2012). Well-documented, wild-collected living plant collections designed to capture high levels of genetic diversity (and curated to avoid hybridization or adaptation to cultivation) can also have high conservation value, particularly for species that do not produce orthodox seeds. Good examples of this are the palm and cycad collections maintained by the Montgomery Botanical Center based in Miami, Florida, U.S.A. (Namoff et al., 2010). For living plant collections, which typically contain lower genetic diversity than other types of ex situ collections, much-needed collaborations such as the broad-based North American Plant Collections Consortium (NAPCC) allow duplication and collection of key species and populations to occur in a strategic fashion (NAPCC, 2011).

Achieving the GSPC Target 8 by 2020 will require the continued integration of collections data, as well as targeted acquisition and germplasm distribution. As technology advances, including the ongoing development of collaborative online databases, we will be able to gain a better understanding of the source and diversity of and can work strategically to build conservation value in collections. The need for effective ex situ plant conservation and the role botanical collections can play are only going to grow in the future. It is imperative that the North American and global botanical communities work together to ensure an effective ex situ safety net is squarely in place for threatened plant species (BGCI U.S., 2012).

Literature Cited

Botanic Gardens Conservation International (BGCI). 2012a. GardenSearch database. <http://www.bgci.org/garden_search.php>, accessed 13 June 2012.

Botanic Gardens Conservation International (BGCI). 2012b. PlantSearch database. <http://www.bgci.org/plant_search.php>, accessed 13 June 2012.

Botanic Gardens Conservation International (BGCI) U.S. 2012. <http://www.bgci.org/usa/MakeYourCollectionsCount>, accessed 19 June 2012.

Center for Plant Conservation (CPC). 2012. <http://www.centerforplantconservation.org>, accessed 19 June 2012.

Convention on Biological Diversity (CBD). 2002. Decision VI/9, Global Strategy for Plant Conservation, 2002–2010. Sixth Ordinary Meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 6), The Hague, The Netherlands. <http://www.cbd.int/decision/cop/?id=7183>, accessed 13 June 2012.

Guerrant, E. O., K. Havens & M. Maunder. 2004. Ex Situ Plant Conservation: Supporting Species Survival in the Wild. Island Press, Washington, D.C.

IUCN. 2010. IUCN Red List of Threatened Species, vers. 2010. <http://www.iucnredlist.org>, accessed 13 June 2012.

Kramer A. & V. Pence. 2012. The challenges of ex situ conservation for threatened oaks. Intl. Oaks 23: 91–108.

Kramer, A., A. Hird, K. Shaw, M. Dosmann & R. Mims. 2011. Conserving North America's Threatened Plants: Progress report on Target 8 of the Global Strategy for Plant Conservation. Botanic Gardens Conservation International U.S., Glencoe, Illinois. <http://www.bgci.org/usa/MakeYourCollectionsCount>, accessed 18 June 2012.

Namoff, S., C. E. Husby, J. Francisco-Ortega, L. R. Noblick, C. E. Lewis & M. P. Griffith. 2010. How well does a botanical garden collection of a rare palm capture the genetic variation in a wild population? Biol. Conserv. 143: 1110–1117.

NatureServe. 2012. NatureServe Explorer: An online encyclopedia of life, vers. 7.1. <http://www.natureserve.org/explorer>, accessed 19 June 2012.

NORMA Official Mexicana NOM-059-SEMARNAT-2001. 2001. Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. <http://www.biodiversidad.gob.mx/pdf/NOM-059-ECOL-2001.pdf>, accessed 18 June 2012.

North American Plant Collections Consortium (NAPCC). 2012. American Public Gardens Association, Kennett Square, Pennsylvania. <http://www.publicgardens.org/content/what-napcc>, accessed 19 June 2012.

Pitman, N. C. A. & P. M. Jorgensen. 2002. Estimating the size of the world's threatened flora. Science 298: 989.

Sharrock, S. & M. Jones. 2011. Saving Europe's threatened flora: Progress towards GSPC Target 8 in Europe. Biol. Conserv. 20: 325–333. <http://link.springer.com/content/pdf/10.1007%2Fs10531-010-9912-z.pdf#page-2>, accessed 29 August 2013.

Sharrock, S., A. Hird, A. Kramer & S. Oldfield. 2010. Saving plants, saving the planet: Botanic gardens and the implementation of GSPC Target 8. Botanic Gardens Conservation International, Richmond, U.K. <http://www.bgci.org/files/Worldwide/GSPC/target_8_report.pdf>, accessed 13 June 2012.